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Summary of Group I Control Technique Guideline Documents for Control of Volatile Organic Emissions from Existing Stationary Sources

Pacific Environmental Services, Inc., Santa Monica, CA

Prepared for

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16. ABSTRACT Control Technique Guideline (CTG) documents have been prepared by the Office of Air Quality Planning and Standards of the U.S. EPA to assist the states in defining reasonably available control technology (RACT) for the control of volatile organic compound emissions from existing stationary sources. This document summarizes those CTGs issued as of January 1978 including a design criteria document for gasoline service stations. A description of each source category is provided, along with RACT and costs to retrofit a model facility.

Source categories included are: surface coating of cans, metal coils, fabric, paper products, automobile and light duty trucks, metal furniture, magnet wire, and large appliances; gasoline terminals, bulk plants and service stations; fixed roof petroleum storage tanks; miscellaneous refinery sources; cutback asphalt; and solvent metal cleaning (degreasing).

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1.0 INTRODUCTION

In accordance with provisions of the 1977 Clean Air Act Amendments, each state in which there is located a designated nonattainment area is required to prepare a revised State Implementation Plan (SIP). The U.S. Environmental Protection Agency (EPA) has specified that the SIP revisions for areas designated as not attaining photochemical oxidant standards should contain, as a minimum, regulations for controlling volatile organic compound (VOC) emissions from stationary sources. These regulations must provide for the implementation of reasonably available control technology (RACT).

To assist the states in defining RACT, the EPA Office of Air Quality Planning and Standards has prepared a series of Control Technique Guideline (CTG) documents. Individual stationary source categories are addressed by the documents. As of January 1978, CTG documents have been issued for 15 stationary source categories. The source categories are:

1. Surface coating of cans
2. Surface coating of metal coils
3. Surface coating of fabrics
4. Surface coating of paper products
5. Surface coating of automobiles and light-duty trucks
6. Surface coating of metal furniture
7. Surface coating of magnet wire
8. Surface coating of large appliances
9. Tank truck gasoline loading terminals
10. Bulk gasoline plants
11. Gasoline service stations - Stage I control
12. Fixed-roof petroleum storage tanks
13. Miscellaneous refinery sources
14. Cutback asphalt
15. Solvent metal cleaning (degreasing)

For each source category, a CTG document describes the source, identifies the VOC emission points, discusses the applicable control

methods, analyzes the costs required to implement the control methods, and recommends regulations for limiting VOC emissions from the source. The purpose of this report is to summarize the CTG documents issued as of January 1978. The summaries are intended to present an introductory overview of the affected source facilities, the magnitude of the VOC emissions emitted from the facilities, and the recommended VOC emission limits. More complete information about the recommended control techniques for an individual source category can be obtained by referring to the specific CTG document cited at the beginning of each section.

2.0 CTG DOCUMENT SUMMARY

The EPA Office of Air Quality Planning and Standards initiated the CTG document series in November 1976 by issuing a document which presents background information on control methods for surface coating operations.[1] The report describes the principal add-on equipment for control of VOC emissions, discusses process and material changes available for reducing VOC emissions, addresses the cost aspects of implementing the control methods, and provides guidance for sampling and analyzing VOC emissions.

Subsequent CTG documents[2-11] have been issued for specific source categories. Summaries of these CTG documents issued as of January 1978, along with the design criteria document[12] for gasoline service stations, are presented on the following pages. Any information not available in the CTG documents was supplemented with input from other sources, where possible.[13-15]

Cost estimates in the CTG documents were normally developed by use of model facilities to represent typical operations. Applicable alternative controls were costed for these model facilities. As such, these costs, even with the broad ranges provided for several of the source categories, may not encompass the actual cost incurred at any specific facility. Stage I control costs for service stations were taken from Reference 13.

The CTG document summaries which follow include a brief discussion of the VOC source category and emission control techniques, as well as a tabular presentation of the following information for each source category:

Affected Facilities - Types of operations, facilities, or equipment covered by the CTG

Number of Affected Facilities - A national count of the operations, facilities, or equipment specified

VOC Emissions Nationwide - Estimate of annual emissions from the source category

VOC Emission Range per Facility - Estimate of annual emissions from a typical facility in the source category

100 Ton/Yr Source Size - The estimated size of a facility which would emit 100 tons/yr of VOC if uncontrolled.

CTG Emission Limit - VOC emission limits as recommended in the CTG document

VOC Reduction Per Facility - Percent emission reduction which can be effected by use of CTG recommended controls

Costs - Values in parenthesis represent net savings

Capital - purchase and installation costs

Annualized - includes operating cost, annualized capital charges plus tax and interest, less value of recovered VOC. Only primary heat recovery or fuel value credit considered

Cost Effectiveness - Cost of control measure per ton of VOC controlled

2.1 SURFACE COATING OF CANS [2]

Cans are used as containers for a wide variety of products and are fabricated in many different sizes, shapes, and styles. As a result, there are major differences in the coating formulations and application methods used by can manufacturers depending on the type of can and the type of product packaged in the can.

Two basic methods are used to fabricate cans. A "three-piece" can is made from a metal blank and two ends. In a separate operation, metal sheets are first roll coated with the appropriate exterior and interior coatings. The cans are then fabricated from the coated sheets. The can body is formed by slitting the sheets into blanks, rolling the blanks to form cylinders, and sealing the side seam. A circular end, also formed from a coated metal sheet, is attached to the can bottom. The interior of the can may be spray coated before the can is filled with a product and the can is sealed with the second end piece. A "two-piece" can is drawn and wall ironed from a shallow cup. After the can is formed, exterior and interior coatings are applied by rolling or spraying techniques. The can is then filled with a product, and the end piece is attached.

The CTG document recommends separate VOC emission limits for the different steps in the can coating process. All of the limits are based on substituting lower organic-solvent borne coatings for the conventional coating currently being applied. The limits for coating metal sheets, two-piece can exteriors and interiors, two-piece can end exteriors, and three-piece can interiors are based on using water-borne coatings. The limits for three-piece can side seam coatings and end sealing compounds are based on increasing the solids content of conventional organic-solvent borne coatings.

Although low organic-solvent borne coatings are being used successfully on some can coating lines, they are presently not commercially available for many can coating applications. Also, not all existing coating application equipment is readily adaptable to using low organic-solvent borne coatings. Consequently, control of VOC emissions from some can coating lines may require the use of add-on control equipment such as incinerators or carbon adsorbers.

SUMMARY OF CTG DOCUMENT FOR COATING OF CANS

AFFECTED FACILITIES	Two- and three-piece can surface coating lines including the application areas and the drying ovens.
NUMBER OF AFFECTED FACILITIES	Estimated to be 460 affected facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from can coating facilities are 140,000 Mg/yr (150,000 ton/yr) which represent about 0.5 percent of the estimated nationwide VOC emissions. [14,15]
VOC EMISSION RANGE PER FACILITY	Typical annual emissions from can coating lines can vary from 13 Mg (14 tons) for end sealing to 240 Mg (260 ton) for two-piece can coating for a plant average of 310 Mg (340 ton).
100 TON/YR SOURCE SIZE	Typical can coating facilities as represented in the CTG would all approach or exceed 100 TPY VOC emissions if uncontrolled.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Sheet coating, two-piece exterior 0.34 kg/l (2.8 lb/gal)* b. Two- and three-piece interior 0.51 kg/l (4.2 lb/gal)* c. Two-piece end exterior 0.51 kg/l (4.2 lb/gal)* d. Three-piece side seam 0.66 kg/l (5.5 lb/gal)* e. End seal compound 0.44 kg/l (3.7 lb/gal)*
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 60 to 100 percent.
COSTS	BASIS: 5,000 scfm facility using thermal or catalytic incineration with primary heat recovery, or adsorption with recovered solvent credited at fuel value. CAPITAL COST: $125,000 - $162,000 ANNUALIZED COST: $42,000 - $71,000 COST EFFECTIVENESS: $135 - $706 per ton VOC

* Coating minus water

2.2 SURFACE COATING OF METAL COILS [2]

Metal coil coating involves the application of prime and/or top coatings to any flat metal sheet or strip that comes in rolls or coils. The type of metals coated include aluminum, aluminum alloys, steel, plated steel, steel alloys, zinc, brass, and copper. The metal is typically cleaned, pretreated, roll coated on one or both sides, dried, and recoiled during a continuous operation. After coating, the metal is used within the same plant or delivered to a customer for fabricating the metal into products.

The CTG document recommends a single emission limit for metal coil coating operations. The limit is based on incineration of the VOC emissions from the application of an organic-solvent borne coating which has a solid content of 25 percent by volume. To comply with the limit, 90 percent of the solvent vapors emitted from the coating line must be captured and burned in an afterburner which has a minimum 90 percent efficiency. This would be equivalent to a solvent (VOC)-borne coating that contains about 65 percent solids. However, low organic-solvent borne (high solids) coatings for steel and other metals are not yet commercially available. Water-borne coatings have been developed for a few metal coil coating operations (e.g., application of primers and low to medium gloss topcoats to aluminum).

SUMMARY OF CTG DOCUMENT FOR COATING OF METAL COILS

AFFECTED FACILITIES	Coil surface coating lines including the application areas, the drying ovens, and the quench areas.
NUMBER OF AFFECTED FACILITIES	Estimated to be 180 facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from coil coating facilities are 30,000 Mg/yr (33,000 ton/yr), which represent about 0.1 percent of the estimated nationwide VOC emissions. [14,15]
VOC EMISSION RANGE PER FACILITY	Average annual VOC emission for a typical facility is estimated to be 180 Mg (200 ton).
100 TON/YR SOURCE SIZE	It is estimated that 2 x 10^6 m^2 (2 x 10^9 ft^2) of coil coated could result in a potential emission of 100 tons of VOC.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.31 kg per liter of coating minus water (2.6 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 70 to 98 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery. Capital cost: ≈ $170,000 Annualized cost: ≈ $ 70,000 Cost effectiveness: $51 - $94 per ton VOC

2.3 SURFACE COATING OF FABRICS [2]

Fabric coating involves the application of decorative or protective coatings to a textile substrate. The CTG definition of "fabric coating" includes the application of rubber coatings to fabrics. Coatings are normally applied to a textile substrate using knife coating or roller coating techniques. For some specialized coating applications, a dip technique may be used.

Vinyl coating involves the application of topcoats to vinyl coated fabrics or vinyl sheets. Roller coating and rotogravure printing techniques are widely used to apply the coatings.

The CTG document recommends separate VOC emission limits for fabric and vinyl coating. The limits for both types of coating are based on the installation of add-on control equipment. To comply with the limits, 90 percent of the VOC solvent vapor emitted from the coating line must be captured and passed to an afterburner or a carbon adsorption unit which has a minimum 90 percent efficiency. Low organic-solvent borne coatings which meet the limits are presently not commercially available.

SUMMARY OF CTG DOCUMENT FOR COATING OF FABRIC AND VINYL

AFFECTED FACILITIES	Fabric and vinyl surface coating lines including the application areas and the drying ovens. Fabric coating includes all types of coatings applied to fabric. Vinyl coating refers to any printing, decorative, or protective topcoat applied over vinyl coated fabric or vinyl sheets.
NUMBER OF AFFECTED FACILITIES	Estimated to be 130 facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emission from fabric coating operations are 100,000 Mg/yr (110,000 ton/yr). [15] The vinyl segment of the fabric industry emits about 36,000 Mg/yr (40,000 ton/yr). VOC from fabric coating represents about 0.4 percent of the estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Average annual VOC emissions are estimated to be 850 Mg (940 ton).
100 TON/YR SOURCE SIZE	Any but the smallest fabric coating facilities should exceed emissions of 100 ton/yr of VOC.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Fabric coating 0.35 kg per liter of coating minus water (2.9 lb/gal). b. Vinyl coating 0.45 kg per liter of coating minus water (3.8 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 80 to 100 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery or adsorption with recovered solvent credited at fuel value. Capital cost: $150,000 - $320,000 Annualized cost: $ 60,000 - $ 75,000 Cost effectiveness: $34 - $39 per ton VOC

2.4 SURFACE COATING OF PAPER PRODUCTS[2]

Paper coating involves the application of decorative, protective, or adhesive coatings to a paper substrate. Affected facilities include plants manufacturing decorated and glazed paper, adhesive tapes and labels, book covers, office copier paper, carbon paper, magnetic tapes, photographic films, and foil gift wrap and packaging.

Coatings are applied to paper using one of three major techniques: knife coating, reverse roller coating, or rotogravure printing. All three application techniques require drying of the coating in an oven. The primary source of VOC emissions during paper coating is the exhaust from the drying ovens.

The CTG document recommends a single VOC emission limit for all paper coating operations. The limit is based on capture and incineration of the VOC solvent vapors emitted from the coating line. Low organic-solvent borne coatings are being used successfully for some paper coating applications. However, low organic-solvent borne coatings are presently not commercially available for all paper coating applications.

SUMMARY OF CTG DOCUMENT FOR SURFACE COATING OF PAPER PRODUCTS

AFFECTED FACILITIES	Paper surface coating lines including the application areas and the drying ovens. The CTG document applies to manufacturing of adhesive tapes, adhesive labels, decorated paper, book covers, office copier paper, carbon paper, typewriter ribbons, and photographic films.
NUMBER OF AFFECTED FACILITIES	SIC 2641, Paper Coating and Glazing, had 397 plants in 1967. Current estimates for this category are 290 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 320,000 Mg/yr (350,000 ton/yr). Of this amount, the manufacture of pressure sensitive tapes and labels is estimated to emit 263,000 Mg/yr (290,000 ton/yr). Emissions from the coating of paper products represent about 1.2 percent of nationwide VOC emissions.[14]
VOC EMISSION RANGE PER FACILITY	Emissions from typical paper coating lines can vary from 23 to 450 kg/hr (50 to 1,000 lb/hr). A plant may have 1 to 20 coating lines. It is estimated that the annual average VOC emission from paper coating plants is 1,480 Mg (1,630 ton).
100 TON/YR SOURCE SIZE	Based on the data given, a plant with one large line or two small lines can exceed 100 ton/yr of VOC emissions.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.35 kg per liter of coating minus water (2.9 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 80 to 99 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery or adsorption with recovered solvent credited at fuel value. Capital cost: $150,000 - $320,000 Annualized cost: $ 60,000 - $ 75,000 Cost effectiveness: $34 - $40 per ton VOC

2.5 SURFACE COATING OF AUTOMOBILES AND LIGHT-DUTY TRUCKS [2]

Automobile and light-duty truck assembly plants receive parts from a variety of sources and produce finished vehicles for sale to dealers. Many coating lines are operated throughout an assembly plant. Coating of the vehicle body and the separate components (e.g., chassis, doors, hoods, fenders, and wheels) begins by applying a prime coat using dip or spray techniques. The coated part is passed through a solvent flashoff area is then cured in an oven. A topcoat is applied in one to three spray applications. Normally, each application is followed by a flashoff and bake cycle. After coating, the parts are sent to other locations in the plant for final assembly of the vehicle. Coatings which are damaged during assembly are recoated directly on the vehicle in the final repair area.

The CTG document recommends separate VOC emission limits for prime, top, and final repair coating operations. The limit for prime coating is based on using the electrodeposition (EDP) dip technique followed by spray application of a 25 volume percent solids water-borne "surfacer" (a supplemental primer). Approximately one-half of the assembly plants currently use EDP dip coating lines for application of primers. Two plants are using the water-borne surfacer. The emission limit for top coating is based on the application of water-borne topcoats. Two plants are using water borne topcoats which meet the recommended limit. The emission limit for final repair coating is based on increasing the solids content of the conventional organic-solvent borne coatings currently used.

The recommended limits do not apply to the application of sound-proofing materials or adhesives. Also, the limits are not intended to apply to commercial automobile refinishers (e.g., body shops and automobile customizers).

Due to technical and economic considerations, it may be reasonable to exempt the conversion of existing water-borne dip prime coating lines to the EDP technique. Also, because of the large expenditures required to convert to water-borne topcoats, it may be reasonable to grant some finite period to develop other low organic-solvent borne coatings which meet the recommended limit.

SUMMARY OF CTG DOCUMENT FOR COATING IN AUTOMOBILE AND LIGHT-DUTY TRUCK ASSEMBLY PLANTS

AFFECTED FACILITIES	Automobile and light-duty truck surface coating lines including the application areas, the flashoff areas, and the drying ovens. The CTG provides no exemptions but notes that it may not be reasonable to convert an existing water-borne dip prime coating system.
NUMBER OF AFFECTED FACILITIES	Identified for the year 1977 to be 47 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from auto and light duty truck plants are 90,000 Mg/yr (100,000 ton/yr). This is about 0.3 percent of estimated VOC emissions nationwide.[14,15]
VOC EMISSION RANGE PER FACILITY	Emissions from typical coating lines can vary from 270 to 1,800 kg/hr (600 to 4,000 lb/hr). Average annual emissions are estimated to be 2,380 Mg (2,620 ton) per subject plant.
100 TON/YR SOURCE SIZE	All uncontrolled coating lines at the assembly plants are expected to emit in excess of 100 tons of VOC per year.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Prime coating 0.23 kg/l (1.9 lb/gal) minus water b. Top coating 0.34 kg/l (2.8 lb/gal) minus water c. Final repair coating 0.58 kg/l (4.8 lb/gal) minus water
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended methods can reduce VOC emissions for: a. Prime coating - 80 to 93 percent. b. Top coating - 75 to 92 percent. c. Final repair coating - not available
COSTS	BASIS: 30 - 65 units per hour facility with substantial variability in both existing operations and potentially applicable control systems. Capital cost: $6,500,000 - $50,000,000 Annualized cost: $2,000,000 - $25,000,000 Cost effectiveness: $1,000 - $4,000 per ton VOC

2.6 SURFACE COATING OF METAL FURNITURE [3]

Metal furniture coating involves the application of prime and top coatings to any piece of metal furniture or any metal part which will be assembled with other metal, wood, fabric, plastic, or glass parts to form a furniture piece. Most metal furniture is finished with a single coat. However, some furniture pieces require a prime coat application. The prime coat is applied by electrostatic spraying, conventional spraying, dipping, or flow-coating techniques. The topcoat or a single coat is also applied by spraying, dipping, or flowcoating techniques.

The CTG document recommends a single emission limit for metal furniture coating operations. This limit is based on the use of low organic-solvent borne coatings. These coatings include water borne, high solids, electrodeposition, and powder coatings. The limit can also be met by the installation of add-on control equipment. To comply with the limit, 80 percent of the VOC solvent vapor emitted from the application of conventional coatings must be destroyed (using an afterburner) or recovered (using a carbon adsorption unit).

SUMMARY OF CTG DOCUMENT FOR COATING OF METAL FURNITURE

AFFECTED FACILITIES	Metal furniture surface coating lines including the application and flashoff areas, and the drying ovens.
NUMBER OF AFFECTED FACILITIES	Approximately 1,400 facilities would be affected nationally.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 90,000 Mg/yr (100,000 ton/yr).[15] This represents about 0.3 percent of estimated VOC emissions nationwide.[14]
VOC EMISSION RANGE PER FACILITY	Estimated average annual VOC emissions are 70 Mg (80 ton) per facility.
100 TON/YR SOURCE SIZE	For a model dip coating line, a plant coating (with no primer), 1,500,000 m^2 (16,200,000 ft^2) of shelving per year would emit about 100 ton/yr.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.36 kg per liter of coating minus water (3.0 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 50 to 99 percent.
COSTS	BASIS: A dip coating facility coating 7,000,000 ft^2 of shelving per year converting to water-borne or electrodeposition: Capital cost: $ 3,000 - $124,000 Annualized cost: $11,000 - $ 25,000 Cost effectiveness: $440 - $657 per ton VOC

2.7 SURFACE COATING OF MAGNET WIRE[4]

Magnet wire coating involves the application of a coating of electrically insulating varnish or enamel to aluminum or copper wire. The wire coating must meet rigid specifications of electrical, thermal, and abrasion resistance. Normally, the wire is both drawn and coated at a plant. The wire is then delivered to a customer for use in the manufacturing of electrical machinery.

Wire is typically cleaned, coated, dried, and rewound on spools during a continuous operation. The coating is applied to the wire by first immersing the wire in a coating bath. Passage of the wire through a coating die (an orifice) scrapes off excess coating and leaves a thin film of the desired thickness. The wire is then passed through an oven to dry the coating. The exhaust from the oven is the primary source of VOC emissions from the wire coating line. The CTG notes that most wire coating ovens built since the early 1960s have internal catalytic incinerators.

The CTG document recommends a single emission limit for wire coating operations. The limit is based on incineration of VOC emissions emitted from the wire coating ovens. To comply with the limit, the afterburner must have a minimum efficiency of 90 percent. An alternative control method is to use low organic-solvent borne coatings. However, low organic-solvent borne coatings are presently not commercially available for all wire coating applications.

SUMMARY OF CTG DOCUMENT FOR COATING OF MAGNET WIRE

AFFECTED FACILITIES	Wire coating oven.
NUMBER OF AFFECTED FACILITIES	Estimated to be 30 plants nationwide. It is not unusual for a wire coating plant to have 50 coating ovens.
VOC EMISSIONS NATIONWIDE	CTG states that there is no way to know how much solvent is actually emitted. About 29,500 metric tons (32,500 ton) of solvent are used each year but much of this is controlled.
VOC EMISSION RANGE PER FACILITY	Emissions from a typical uncontrolled oven will be approximately 12 kg/hr (26 lb/hr). The average annual emissions of VOC per plant are estimated to be 314 Mg (340 ton).[15]
100 TON/YR SOURCE SIZE	CTG indicates that each of the facilities, if uncontrolled, could easily exceed 100
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.20 kg per liter of coating minus water (1.7 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 90 percent.
COSTS	BASIS: 10,000 scfm facility controlling VOC by use of incineration with primary heat recovery. Capital cost: Approximately $220,000 Annualized cost: $85,000 - $115,000 Cost effectiveness: $105 - $140 per ton VOC

2.8 SURFACE COATING OF LARGE APPLIANCES [5]

Large appliance coating involves the application of prime and top coatings to components assembled into large appliances. The CTG definition of "large appliances" includes doors, cases, lids, panels, and interior support parts of residential and commercial washers, dryers, ranges, refrigerators, freezers, water heaters, dishwashers, trash compactors, air conditioners, and other similar products. Application of prime or single coats to components may be by dipping, flowcoating, or spraying techniques. Dip coating is typically used for small parts while flowcoating is used for large parts. The topcoat is usually applied using spray techniques.

The CTG document recommends a single emission limit for large appliance coating operations. The limit is based on the use of low organic-solvent borne coatings. To comply with the limit, the coatings must contain at least 62 volume percent solids or any equivalent water-borne coating. The limit can also be met by the installation of add-on control equipment. To comply with the limit, 80 percent of the VOC solvent emitted from the application of conventional coatings must be destroyed (using an afterburner) or recovered (using a carbon adsorption unit).

SUMMARY OF CTG DOCUMENT FOR COATING OF LARGE APPLIANCES

AFFECTED FACILITIES	Large appliance surface coating including the prime, single, or topcoat application areas, the flashoff areas, and the oven.
NUMBER OF AFFECTED FACILITIES	Estimated to be about 270 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 42,000 Mg/yr (46,000 ton/yr)[15] which represent about 0.2 percent of estimated nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	The average annual VOC emissions are estimated to be 170 Mg (185 ton).
100 TON/YR SOURCE SIZE	Extrapolating the model facility data, a plant coating 221,000 clothes washer cabinets per year would exceed 100 ton/yr emissions of uncontrolled VOC.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.34 kg per liter of coating minus water (2.8 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 79 to 95 percent.
COSTS*	BASIS: 768,000 clothes washer cabinets coated per year using various combinations of control techniques. Capital cost: $70,000 - $1,250,000 Annualized cost: ($300,000) - $350,000 Cost effectiveness: ($1,050) - $1,180 per ton VOC

* ($---) indicates savings

2.9 TANK TRUCK GASOLINE LOADING TERMINALS[6]

A "terminal" is defined by the CTG document as a gasoline distribution facility which has a daily gasoline throughput greater than 76,000 liter/day (20,000 gal/day). The daily gasoline throughput at a typical size terminal is 950,000 liter/day (250,000 gal/day). Only the loading of gasoline tank trucks is covered by the CTG document.

Tank trucks are filled at loading racks. These facilities contain the equipment necessary to meter and to deliver the gasoline from the storage tanks to the tank trucks. The equipment includes pumps, piping, valves, fittings, meters, and loading arm assemblies. The loading rack may be an elevated structure for overhead splash fill or submerged fill of tank trucks. The loading rack may also be a ground level facility for bottom loading of tank trucks.

The CTG document recommends a single VOC emission limit for loading of gasoline tank trucks at terminals. To comply with the limit, an active vapor control system must be installed to condense, absorb, adsorb, or incinerate the VOC vapors. Control equipment to fulfill this requirement is presently commercially available. However, leakage from the vapor control system and tank trucks must be minimized by a good maintenance and inspection program.

Using the recommended control limits, VOC emissions can be reduced by 87 to over 97 percent (neglecting any VOC losses due to leakage) as a function of the concentration of gasoline vapor in an empty tank truck.

SUMMARY OF CTG DOCUMENT FOR TANK TRUCK GASOLINE LOADING TERMINALS

AFFECTED FACILITIES	Any tank truck loading operations at the primary wholesale outlet for gasoline which delivers at least 76,000 liter/day (20,000 gal/day). A facility which delivers under 20,000 gal/day is covered by the CTG for bulk plants.
NUMBER OF AFFECTED FACILITIES	According to the Bureau of Census, there were 1,925 terminals in 1972. Current estimates are about 1,600 terminals nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 250,000 Mg/yr (275,000 ton/yr)[14,15] which represent about 0.9 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Without vapor recovery systems, VOC emissions can range from 0.6 to 1.4 g/1,000 liters of throughput (5 to 12 lb/1,000 gal). For a typical size facility having a throughput of 950,000 liter/day (250,000 gal/day) VOC emissions are estimated to be 200 Mg/yr (220 ton/yr).
100 TON/YR SOURCE SIZE	For an uncontrolled facility with fixed roof tanks, a 133,000 liter /day (35,000 gal/day) plant would result in VOC emission of 100 ton/yr. For an uncontrolled facility with floating roof tanks, a 454,000 liter/ day (120,000 gal/day) facility would result in VOC emissions of 100 ton/yr.
CTG EMISSION LIMIT	The recommended emission limit is 80 mg/liter (0.67 lb/1,000 gal) of gasoline loaded. This limit is based on submerged fill and vapor recovery/control systems. No leaks in the vapor collection system during operation is a requirement.
VOC REDUCTION PER FACILITY	A minimum control of 87 percent is expected for the loading facility.
COSTS	BASIS: 250,000 gal/day facility with active vapor control systems. Capital cost: $140,000 - $195,000 Annualized cost: $ 20,000 - $ 30,000 Cost effectiveness: $120 - $180 per ton VOC

2.10 BULK GASOLINE PLANTS[7]

A "bulk plant" is defined by the CTG document as a gasoline distribution facility having a daily gasoline throughput of 76,000 liter (20,000 gal) or less per day. The daily gasoline throughput at a typical size bulk plant is 14,000 to 37,000 liter/day (4,000 to 5,000 gal/day).

The VOC losses occur from the storage tanks when temperature induced pressure expels vapor laden air (breathing loss). Losses also occur during draining and filling of the tanks (working loss). Fugitive losses can occur from valves, truck hatches, piping, and pump seals. Only the filling and draining of gasoline tanks and trucks are covered by the CTG document. Account tank trucks are used to deliver gasoline to bulk plant customers. The tank trucks are filled at loading racks similar to the types described for loading tank trucks at terminals (refer to Section 2.9). A typical bulk plant has one loading rack.

The recommended CTG limit is stated in terms of equipment specifications and operating procedures. Three levels of increasingly more effective VOC control alternatives are applicable to bulk plants. The alternatives are:

Alternative 1 - Submerged filling of tank trucks.

Alternative 2 - Alternative 1 plus a vapor balance (displacement) system to control VOC emissions from filling of bulk plant storage tanks. The vapors displaced from the storage tank are transferred to the tank truck being unloaded. Ultimately, the vapors are recovered when the tank truck returns to the terminal.

Alternative 3 - Alternative 2 plus a vapor balance system to control VOC emissions from filling of account tank trucks. The vapors displaced from the account tank truck are transferred to the storage tank.

As a minimum requirement, the CTG recommends application of Alternative 2 to all bulk plants. It may not be reasonable to apply Alternative 3 to some bulk plants. The reason is the costs of installing a vapor balance system on existing loading racks and tank trucks may be too high for small, independent bulk plants to continue operation. The cutoff for potentially severe economic effects is expected to occur for bulk plants operating at less than 15,000 liter/day (4,000 gal/day) of gasoline throughput.

SUMMARY OF CTG DOCUMENT FOR BULK GASOLINE PLANTS

AFFECTED FACILITIES	A wholesale gasoline distribution facility which has a maximum daily throughput of 76,000 liters (20,000 gal) of gasoline. Facilities which deliver over 20,000 gal/day are covered under the CTG for terminals. Potentially severe economic hardship may be encountered by bulk plants which deliver less than 4,000 gal/day.
NUMBER OF AFFECTED FACILITIES	There were 23,367 bulk plants in 1972 according to the Bureau of Census. Current estimates are about 18,000 bulk gasoline plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 150,000 Mg/yr (165,000 ton/yr) [14,15] which represent about 0.6 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	A facility with three storage tanks would have VOC emissions approximating 4.4 kg/day (20 lb/day) plus a range of 0.2 to 3.0 g/1,000 liters throughput (2.0 to 25.0 lb/1,000 gal). For a typical size facility having a throughput of 18,900 liter/day (5,000 gal/day) average VOC emissions are estimated to be 15 Mg/yr (17 ton/yr).
100 TON/YR SOURCE SIZE	None.
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specification alternatives: 1. Submerged fill of outgoing tank trucks. 2. Alternative 1 + vapor balance for incoming transfer. 3. Alternative 2 + vapor balance for outgoing transfer.
VOC REDUCTION PER FACILITY	Emission Reductions / Total Plant / All Transfers Alternative 1: 22 percent / 27 percent Alternative 2: 54 percent / 64 percent Alternative 3: 77 percent / 92 percent
COSTS	BASIS: 4,000 gal/day throughput using submerged fill and vapor balance for both incoming and outgoing transfers: Capital cost: $4,000 - $10,000 Annualized cost: $ 100 - $ 1,200 Cost effectiveness: $9 - $90 per ton VOC

2.11 GASOLINE SERVICE STATIONS - STAGE I [12]

No CTG document has been prepared by the EPA for this source category. However, the EPA document, Design Criteria for Stage I Vapor Control Systems - Gasoline Service Stations, recommends VOC emission controls for the transfer of gasoline from delivery trucks to service station storage tanks. (Recommendations for control of VOC emissions for the dispensing of gasoline, Stage II vapor control systems, may be issued in a future EPA document.)

A gasoline service station is a retail gasoline outlet. The gasoline is normally stored in underground storage tanks. A typical service station will dispense 110 to 150 m^3 (30,000 to 40,000 gal) of gasoline per month.

The recommended Stage I emission controls are stated in terms of equipment specifications and operation procedures. These controls consist of submerged fill of the storage tanks, vapor balance between the vapor space in the delivery tank and the storage tank, and assurance that the vapor line is connected. A periodic inspection of the delivery trucks is also recommended. The inspector should certify that a tank pressurized to 12.7 cm (5 in) of water will not drop to 5.1 cm (2 in) of water in less than 3 minutes. In addition, the inspector should check for leaks from transfer lines, manifolds, and valves.

SUMMARY OF DOCUMENT FOR GASOLINE SERVICE STATIONS - STAGE I

AFFECTED FACILITIES	Transfer of gasoline from delivery trucks to service station storage tanks. No exemptions were noted in the "Design Criteria for Stage I Vapor Control Systems."
NUMBER OF AFFECTED FACILITIES	Estimated to be 180,000 retail gasoline service stations nationwide. There are 240,000 other gasoline dispensing outlets.
VOC EMISSIONS NATIONWIDE	For transfer of gasoline to service station storage tanks, VOC emissions estimated to be 400,000 Mg/yr (440,000 ton/yr)[14,15] which represents about 1.5 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Without vapor controls, VOC emissions are estimated to be 1.4 kg/1,000 liters (11.5 lb/1,000 gal) of throughput. For a typical facility having a throughput of 151,000 liter/mo (40,000 gal/mo) VOC emissions would be 2.5 Mg/yr (2.8 ton/yr) for Stage I.
100 TON/YR SOURCE SIZE	For an uncontrolled facility, a 2,800,000 liter/mo (750,000 gal/mo) throughput results in VOC emissions of 100 ton/yr. Very few service stations will have this size throughput. The emissions include both Stage I and Stage II losses.
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications. Recommended controls are submerged fill of storage tanks, vapor balance between truck and tank, and a leak free truck and vapor transfer system.
VOC REDUCTION PER FACILITY	Stage I control can reduce transfer losses by 95+ percent and total facility losses by 50 percent.
COSTS*	BASIS: Application of submerged fill and vapor balance to a service station with three tanks. Capital cost: $600 Annualized cost: ($200) Cost effectiveness: ($110) per ton VOC[13]

* ($---) indicates savings

2.12 FIXED-ROOF PETROLEUM STORAGE TANKS [8]

A fixed-roof petroleum storage tank consists of a cylindrical, steel shell covered by a cone shaped roof. Fixed-roof storage tanks are used for storage of gasoline, crude oils, fuel oils, and other types of petroleum liquids. The tanks are located at refineries, at terminals, at bulk plants, at tank farms, along pipelines, in oil production fields, and at other industrial facilities. The CTG document is applicable to fixed-roof storage tanks having a capacity greater than 150,000 liters (40,000 gal) and storing petroleum liquids which have a true vapor pressure greater than 10.5 kPa (1.5 psia). Fixed-roof storage tanks which have capacities less than 1,600,000 liters (420,000 gal) used to store only produced crude oil and condensate prior to lease custody transfer are exempt.

Normally, a tank is equipped with pressure/vacuum relief valves set to operate at low pressure variations. The valves are designed to contain within the tank minor fluctuations in the vapor volume. When pressure inside the tank exceeds the relief pressure, VOC vapors are released to the atmosphere. The expansion of vapors in the tank due to changes in ambient temperature and pressure result in VOC emissions termed "breathing losses." Additional VOC emissions termed "working losses" result from vapors emitted from a tank as a result of filling and emptying operations.

The recommended CTG emission limit is stated in terms of equipment specifications and maintenance requirements. The installation of internal floating roofs inside fixed-roof tanks is recommended. Emission reductions of more than 90 percent can be achieved by installing the internal floating roofs. The CTG document also permits the use of alternative control equipment of equivalent efficiency.

SUMMARY OF CTG DOCUMENT FOR PETROLEUM LIQUID STORAGE IN FIXED-ROOF TANKS

AFFECTED FACILITIES	Fixed-roof storage tanks having a capacity greater than 150,000 liters (40,000 gal or 950 bbl) and storing petroleum liquids which have a true vapor pressure greater than 10.5 kPa (1.5 psia). Fixed-roof tanks which have capacities less than 1,600,000 liters (420,000 gal or 10,000 bbl) used to store produced crude oil and condensate prior to lease custody transfer are exempt.
NUMBER OF AFFECTED FACILITIES	Estimated for the year 1976 to be 7,300 tanks nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 560,000 Mg/yr (616,000 ton/yr) which represent about 2.1 percent of the estimated VOC emissions nationwide. Emissions of VOC from fixed-roof tanks are 4.7 times that from existing floating roof tanks, although the total capacity of fixed-roof tank storage is less. [14]
VOC EMISSION RANGE PER FACILITY	VOC emission ranges for gasoline or crude oil storage assuming 5 to 20 turnovers per year and a true vapor pressure of 13.8 to 69 kPa (2.0 to 10 psia).

Size →	Small	Medium	Large
Capacity (gal)	420×10^3	2.3×10^6	6.3×10^6
Dimensions diam. x ht. (ft)	50 x 30	100 x 40	150 x 48
VOC Emissions			
Gasoline (Mg/yr)	12 - 113	52 - 535	123 - 1,353
(ton/yr)	13 - 125	57 - 590	135 - 1,490
Crude Oil (Mg/yr)	7 - 65	28 - 311	66 - 796
(ton/yr)	8 - 72	30 - 340	75 - 875

100 TON/YR SOURCE SIZE	Variable depending on many parameters including the type and vapor pressure of the petroleum liquid stored, schedule of tank filling and emptying, and the geographic location of tank. As shown above a medium size tank can easily exceed 100 ton/yr emissions of VOC.
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications: Installation of internal floating roofs or alternative equivalent control. Types of alternative controls are not specified in the CTG document.
VOC REDUCTION PER FACILITY	VOC emission reduction of 90+ percent can be achieved by installation of internal floating roofs.
COSTS*	BASIS: 55,000 bbl (2,310,000 gal) medium size tank with gasoline or crude oil, with true vapor pressure range of 14 to 69 kPa (2 to 10 psia) and 5 to 20 turnovers per year. Capital cost: $31,000 Annualized cost: $(70,000) to 2,100 Cost effectiveness: ($123) - $73 per ton VOC

* ($-) indicates savings

2.13 PETROLEUM REFINERY PROCESSES[9]

The CTG document addresses three VOC emission sources located at refineries: vacuum producing systems, wastewater separators, and process unit turnarounds.

Three types of vacuum producing systems may be operated at a refinery: steam ejectors with contact condensers, steam ejectors with surface condensers, and mechanical vacuum pumps. If uncontrolled, the noncondensable VOC vapors discharged from a final steam jet ejector stage or a mechanical vacuum pump are released to the atmosphere.

Wastewater separators are used to separate free oil and settleable solids from process water and runoff water collected throughout the refinery. The oils are skimmed from the surface and are processed to recover the usable oil. If uncontrolled, VOC emissions to the atmosphere will occur due to evaporation of volatile organic compounds contained in the wastewater.

Refinery process units are periodically shutdown and emptied for internal inspection, maintenance, and repair. The primary source of VOC emissions during a turnaround results due to depressurizing a process vessel and venting the vapors to the atmosphere.

The recommended CTG emission limits are stated in terms of equipment specifications and operating procedures. To control VOC emissions from vacuum producing systems, the recommended method is incineration of noncondensable vapors. The vapors can be burned in flare, or compressed and added to the refinery fuel gas supply. Recommended control of VOC emissions from wastewater separators consists of covering the forebay and separator sections. When a process unit is shut down for a turnaround, the recommended operating procedure is to vent all vapors to a flare or a vapor recovery system.

SUMMARY OF CTG DOCUMENT FOR PROCESSES AT PETROLEUM REFINERIES

AFFECTED FACILITIES	The affected facilities and operations are: a. Vacuum producing systems (VPS) b. Wastewater separators (WS) c. Process unit turnarounds (PUT) - (i.e., shutdown, repair or inspection, and start up of a process unit) The CTG provides no exemptions.
NUMBER OF AFFECTED FACILITIES	No estimates of the number of individual facilities are available. There are approximately 285 refineries nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual nationwide emissions from vacuum producing systems (VPS), wastewater separators (WS), and process unit turnarounds (PUT) are 730,000 Mg/yr (800,000 ton/yr) which represent about 2.7 percent of estimated VOC emissions nationwide.[14]
VOC EMISSION RANGE PER FACILITY	The estimated average annual VOC emissions from affected facilities at a petroleum refinery are 2,560 Mg (2,820 ton). Emission factors used for estimating uncontrolled, reactive VOC emissions are: a. VPS - 145 kg/$10^3 m^3$ (50 lb/10^3 bbl) refinery throughput b. WS - 570 kg/$10^3 m^3$ (200 lb/10^3 bbl) refinery throughput c. PUT - 860 kg/$10^3 m^3$ (301 lb/10^3 bbl) refinery throughput
100 TON/YR SOURCE SIZE	The following annual refinery throughputs will result in 100 ton/yr uncontrolled VOC emissions from each affected facility type: a. VPS - 627 x $10^3 m^3$ (3.9 x 10^6 bbl) b. WS - 160 x $10^3 m^3$ (1.0 x 10^6 bbl) c. PUT - 105 x $10^3 m^3$ (0.67 x 10^6 bbl)
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications: a. VPS - incineration of VOC emissions from condensers b. WS - covering separator forebays c. PUT - combustion of vapor vented from vessels
VOC REDUCTION PER FACILITY	Implementing the recommended controls can reduce VOC emissions by: a. VPS - 100 percent b. WS - 95 percent c. PUT - 98 percent.
COSTS*	BASIS: A 15,900 m^3/day (100,000 bbl/day) refinery using the recommended control equipment. Capital cost $1,000: 24 - 52; WS 63; PUT - 10 units 98 Annualized cost $1,000: (95) - (89); WS (310); PUT - 10 units 26 Cost effectiveness $/ton : (104) - (96); WS (90); PUT - 10 units 5

* ($-) indicates savings

2.14 CUTBACK ASPHALT[10]

Cutback asphalt is a base asphalt liquefied with a petroleum distillate. The distillate used as a diluent can vary from high volatility naphtha to low volatility fuel oils depending on the type of asphalt desired. The volatility of the diluent determines whether the cutback asphalt is rapid, medium, or slow curing asphalt. The diluent in cutback asphalt ranges from 13 to 50 percent by volume and averages 35 percent. Asphalts can also be liquefied with water as an emulsifying agent. This type of asphalt is termed "emulsified asphalt." Both cutback and emulsified asphalts are in common use.

In most applications, cutback asphalt is sprayed directly on the road surface as a bonding agent or as part of a new surface layer. It is also mixed with an aggregate for pothole repair and shoulder work.

Another use of asphalt is as a hot mix which is used for paving new roads or resurfacing existing roads. In this application the asphalt is liquefied by melting at high temperatures prior to mixing with an aggregate to produce the hot mix. Such a use of asphalt does not require the addition of distillates and therefore is not a source of VOC.

The CTG document recommends sole use of emulsified asphalt. Because true emulsified asphalt contains no volatile organic compounds, substitution of emulsified asphalt for cutback asphalt reduces VOC emissions by 100 percent. Concerns have been raised that emulsified asphalt may be unsuitable for use as a penetrating prime coat, for long term stockpiling, and for use in cold weather. However, emulsified asphalt is currently successfully used in the States of New York, Pennsylvania, and Indiana during winter conditions.

SUMMARY OF CTG DOCUMENT FOR CUTBACK ASPHALT

AFFECTED FACILITIES	Roadway construction and maintenance operations using asphalt liquefied with petroleum distillates.
NUMBER OF AFFECTED FACILITIES	No estimates were obtained.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 655,000 Mg/yr (720,000 ton/yr). This represents about 2.4 percent of estimated VOC emissions nationwide.[14]
VOC EMISSION RANGE PER FACILITY	Estimated VOC emissions from cutback asphalt production are: a. 0.078 kg/kg (ton/ton) of slow cure asphalt. b. 0.209 kg/kg (ton/ton) of medium cure asphalt. c. 0.204 kg/kg (ton/ton) of rapid cure asphalt.
100 TON/YR SOURCE SIZE	Not generally applicable to this source category since the main sources of emissions are the road surfaces where the asphalt is applied.
CTG EMISSION LIMIT	Substitute water and nonvolatile emulsifier for petroleum distillate blending stock.
VOC REDUCTION PER FACILITY	VOC emission reductions are approximately 100 percent.
COSTS*	BASIS: The major cost associated with control of VOC is the price difference between cutback and emulsified asphalt. A price differential of 5 cent/gallon savings to 1 cent/gallon penalty results in a cost effectiveness range of ($73) - $15 per ton VOC.

* ($---) indicates savings

2.15 SOLVENT METAL CLEANING [11]

Solvent metal cleaning or "degreasing" involves using organic solvents to clean and to remove oils, greases, and other soils from metal surfaces. There are three basic types of organic solvent degreasers: cold cleaners, open-top vapor degreasers, and conveyorized degreasers. A cold cleaner consists of a tank containing a nonboiling organic solvent into which parts are batch loaded for cleaning. An open-top vapor degreaser consists of a tank containing an organic solvent heated to its boiling point. Open-top vapor degreasers are also batch loaded. A conveyorized degreaser allows continuous degreasing operations using either nonboiling or boiling organic solvents. Metal parts are loaded continuously into the degreaser by various types of conveyor systems.

The recommended CTG limits are stated in terms of equipment specifications and operating procedures. Two detailed control options are recommended for each type of degreaser. In general, one control option is based on proper operating procedures and simple, inexpensive control equipment. The second control option includes additional requirements to improve the effectiveness of the VOC emission control system. Depending on the control option, recommended control equipment can be as simple as a manually operated tank cover or as complex as a carbon adsorption system. Recommended operating procedures include correct operation of equipment to minimize solvent carryover, prompt repair of leaking equipment, and proper disposal of spent solvents. It is recommended that the reader refer to the CTG document for a complete description of the specific control options.

The CTG document recommends conveyorized degreasers smaller than 2.0 m^2 (21.5 ft^2) of air/vapor interface should be exempt from a requirement for a major control device. Also, open-top vapor degreasers smaller than 1.0 m^2 (10.8 ft^2) of open area should be exempt from the application of refrigerated chillers or carbon adsorbers.

SUMMARY OF CTG DOCUMENT FOR SOLVENT METAL CLEANING

AFFECTED FACILITIES

Three types of solvent degreasers are affected:

a. Cold cleaner: batch loaded, nonboiling solvent degreaser.
b. Open top vapor degreaser: batch load, boiling solvent degreaser.
c. Conveyorized degreaser: continuously loaded, conveyorized solvent degreaser, either boiling or nonboiling.

Open top vapor degreasers smaller than 1 m^2 of open area are exempt from the application of refrigerated chillers or carbon adsorbers.

Conveyorized degreasers smaller than 2.0 m^2 of air/vapor interface are exempt from a requirement for a major control device.

NUMBER OF AFFECTED FACILITIES

Estimates of the number of solvent degreasers nationwide for the year 1974 are:

a. Cold cleaners (CC) - 1,220,000.
b. Open top vapor degreasers (OT) - 21,000.
c. Conveyorized degreasers (CD) - 3,700.

VOC EMISSIONS NATIONWIDE

Estimates of annual nationwide emissions are:

a. CC - 380,000 Mg/yr (419,000 ton/yr).
b. OT - 200,000 Mg/yr (221,000 ton/yr)
c. CD - 100,000 Mg/yr (110,000 ton/yr) [14]

which represent about 2.5 percent of estimated VOC emissions nationwide.

VOC EMISSION RANGE PER FACILITY

Averaged emission rates per degreaser:

a. CC - 0.3 Mg/yr (0.3 ton/yr).
b. OT - 10 Mg/yr (11 ton/yr).
c. CD - 27 Mg/yr (30 ton/yr).

100 TON/YR SOURCE SIZE

Data indicate that on an average 10 open top degreasers or 4 conveyorized degreasers may emit 100 ton/yr.

CTG EMISSION LIMIT

The VOC emission limit is recommended in terms of equipment specifications and operation procedures. Required control equipment can be as simple as a manually operated tank cover or as complex as a carbon adsorption system depending on the type, size, and design of the degreaser.

VOC REDUCTION PER FACILITY

The actual percent VOC reduction will vary depending on the control equipment installed and the operational procedures followed. Recommended control methods can reduce VOC emissions by:

a. CC - 50 to 53 percent (± 20 percent).
b. OT - 45 to 60 percent (± 15 percent).
c. CD - 25 to 60 percent (± 10 percent).

COSTS *

BASIS: CC of 0.5 m^2 work area using high volatility solvent (a) and low volatility solvent (b); OT of 1.67 m^2 work area; and CD of 3.9 m^2 work area.

	Capital Cost $1,000	Annualized Cost $1,000	Cost Effectiveness $/ton VOC
CC-a	0.025	0.001	20
CC-b	0.065	(0.026)	(240)
OT	0.3 - 10.3	(0.8) - 0.8	(360) - 220
CD	7.5 - 18	(3.7) - 1.5	(260) - 260

* ($---) indicates savings

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